Space Weather Technical Forecast

Issued on Wednesday, 04 September 2024 at 01:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares expected, slight chance of X-flares. Slight chance of G1 Geomagnetic storms Day 1 (04 Sep). Increasing chance of S1/Minor Radiation Storm level.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity was Moderate in the past 24hrs, with several M-class flares. The strongest one was an impulsive M3.3 peaking at 03/1602 UTC from AR3813 in the southeast quadrant. There are currently nine sunspot regions on the visible disc. AR3807 (Fki/Beta-Gamma-Delta), in the southwest, is the largest region and has developed a delta spot in the intermediate portion of the region. AR3806 (Eai/Beta-Gamma-Delta) near south centre disc consists of numerous spots and has developed a new delta within the trailing spot. AR3813 (Ekc/Beta-Gamma) close to the far southeast appears to be a large and complex region, but foreshortening prevents a confident assessment. A further region close to the southeast limb continues to emerge and may be magnetically connected to AR3813 and a region beyond the limb. All other regions are relatively simple and stable at present.

A halo CME was observed on coronagraph imagery around 03/0810UTC. While some dimming was detected, there was no evidence of any flare or filament lift-off associated with this event, leading us to believe that this CME is far-sided. A weak CME was also observed off the northeast limb around 03/2030 UTC and while it is not estimated to be Earth-directed, there is not sufficient imagery to run a detailed analysis. No other Earth directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar wind parameters as measured by ACE at L1 are indicative of a return to a slow regime. The solar wind speed reduced from 450 to 370 km/s, along with a below average density. The Interplanetary Magnetic Field, Bt, was moderate but reduced slightly over time, from 12 to 8nT. The north-south component, Bz, continued to fluctuate, ranging between -4nT and +9nT, but more weakly whilst remaining largely positive. Phi angle was largely negative (towards the Sun), only switching briefly to positive. Resulting geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 has been rising very slightly in response to the M5.5 flare on 01 Sep but remains below the S1 level, peaking at 6.4 pfu at 03/1355 UTC. High energy electron flux (greater than 2MeV) observed at GOES16 was at background but did rise to moderate levels, peaking at 550pfu at 03/1715 UTC. The 24-hour fluence remained well below the Active threshold but displayed a sharp rising trend, with 1.34e7 integrated pfu observed at 04/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected with a slight chance of isolated X-flares. The main flare risk is currently from AR3806, AR3807 and AR3813.

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Solar Wind / Geomagnetic Activity: A large CME off the southeast limb on 01 Sep is expected to mostly pass well behind Earth's orbit, but glancing impacts at Earth cannot be ruled out. Confidence is low but impacts could be felt on Day 1 (04 Sep). Two coronal holes are currently present on the western hemisphere, CH67/- and CH/65/+. The HSS associated with the negative coronal hole may enhance the solar wind on Day 3 (06 Sep) and the HSS associated with the positive one on Day 4 (07 Sep).

On the whole, mainly Quiet to Unsettled (Kp 1-3) activity is expected but there is a slight chance of G1/Minor Storm intervals (Kp 5) on Day 1.

Energetic Particles / Solar Radiation: High energy proton flux is above background levels, but below the S1/Minor Radiation Storm threshold. There is a slight and increasing chance of exceeding S1 in the coming days. High energy electron flux is expected to remain at background to moderate levels, perhaps rising later in the period following any CME effects. There is a slight chance of fluence reaching the Active threshold by the end of the period.

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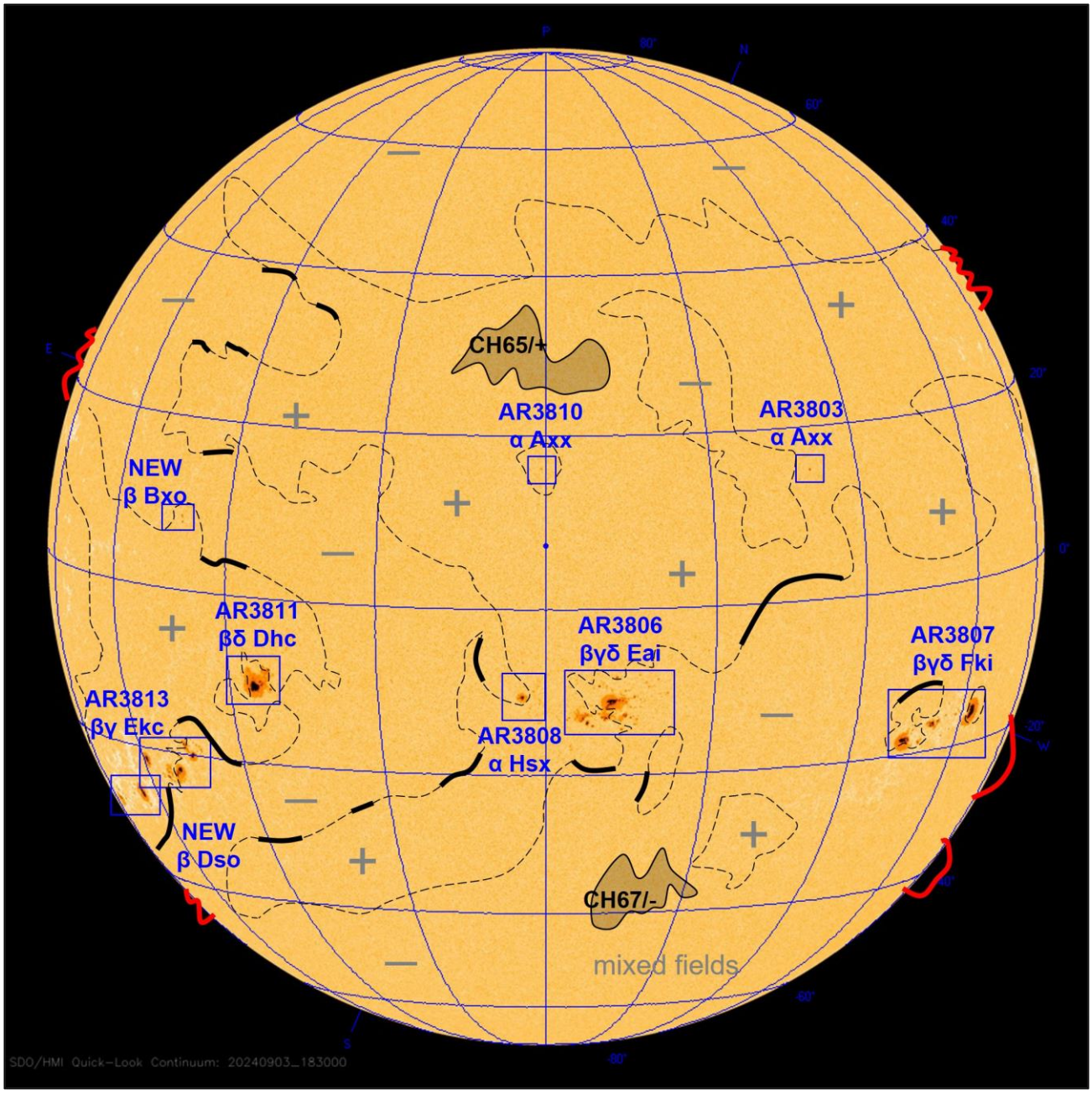
Figure 1. Solar Analysis Valid 03/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A large eruption off the southeast limb through the UTC afternoon of 01 Sep has been analysed, with the bulk of the CME passing well behind Earth's orbit. However, LASCO C3 imagery does show a faint asymmetric halo, likely shock from the eruption. As such, potential glancing impacts at Earth cannot be ruled out for this CME. Confidence is low but impacts could be felt on Day 1 (04 Sep).

Solar winds are indicative of a slow regime, with slow-ambient speeds and below average density. Two coronal holes may enhance the solar wind over the next few days, CH67/- and CH65/+. The HSS associated with the negative coronal hole may is expected to connect with Earth on Day 3 (06 Sep) and the HSS associated with the positive one on Day 4 (07 Sep), which is somewhat supported by the MOSWOC persistence model (SWPM), the solar wind expected to increase roughly by 100 km/s to reach slightly elevated levels and perhaps peak close to 500 km/s. There is however a caveat. With Earth tending to connect more favourably with positive coronal holes in Autumn, the enhancement expected on Day 3 may well be minimal or simply non-existent.

On the whole, mainly Quiet to Unsettled (Kp 1-3) activity is expected but there is a slight chance of G1/Minor Storm intervals (Kp 5) on Day 1.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1549	Partial	AR3813	SE Limb	1250 km/s	04/0600 UTC	Partial halo shock (not modelled in Enlil). May glance Earth. Low confidence

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Radio Blackouts - X-Ray Flares:
There are currently nine sunspot regions on the visible disc, two of which are unnumbered. AR3807 in the southwest remains the largest region with continued growth, decay, and consolidation in the central portion with the emergence of more mature penumbra and a faint delta spot. AR3806 lying south centre disc has shown some recent growth. Consisting of numerous spots AR3806 has developed at least two delta spots, one in the lead and one in the trailing group.

AR813 in the southeast appears to be a large and complex region, but due to foreshortening it is hard to distinguish the exact magnetic configuration at present. This region is showing significant looping in SDO imagery, however. The new region that lies in the far southeast is currently a unipolar region, however, there is evidence of a further spot emerging across the limb which may lie within the same area of plage and be considered part of the same sunspot group. This new region on the limb may be magnetically connected and contributing to the looping visible on AIA-0171 and AIA-0094 imagery.

All other regions are relatively small, simple and stable at present.

Further M-class flares are expected, with a chance of isolated X-class flares. Whilst AR3807 is expected to rotate off the disc early on Day 3 (06 Sep), the flare risk from this region will remain until it is around 24 hours over the limb, so a flat trend is maintained throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	25	25	25	25

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Figure 2: Latest X-Ray Flare activity, as observed at GOES-18

Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18, is above background levels in response to the large eruption and associated M5.5 flare off the southeast limb during the UTC afternoon of 01 Sep. However, the upward trend appears to be levelling off and it is considered unlikely to reach the S1/Minor Radiation Storm threshold at this time, unless further notable flares occur.

There are several regions on the disc which could give an increase in proton flux should they produce larger flares, including AR3807 and AR3806. Ordinarily, AR3813 would be considered a low risk of exceeding S1 from its current location, but given it has already produced a proton response at Earth from the east limb, this region will pose an increasing risk of proton flux increases as it rotates westward.

Overall, there is slight but increasing trend in the possibility of reaching the S1 threshold in the coming days, should there be any larger flares from any of the aforementioned regions.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	25	25
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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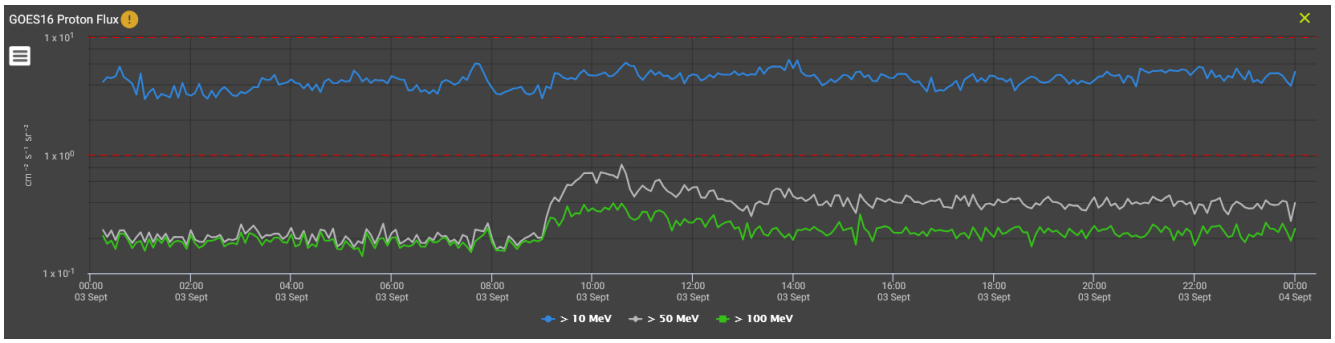
Figure 3: Latest Proton Flux, as observed at GOES-16



High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES-16 is at background to moderate levels, with recent CME effects driving a very minor increase in flux at the diurnal maxima. This is likely to gradually tail off over the next few days in the absence of CME influence. However, there is the potential for some CME shock at Earth on Day 1 (04 Sep), which may cause a sharp drop in electron flux to background levels in the short term. Depending on the level of geomagnetic response to this feature, it may then drive an increase in electron flux later in the period. Confidence is low, however, on whether these CME effects arrive at Earth or not.

Overall, the 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold for much of this period, perhaps with a rising trend later if we do see CME influence with a geomagnetic response. Therefore there is a slight chance of exceeding the Active threshold by the end of the period. MOSWOC REFM is showing the most likely forecast, below Active, but will not be taking into account any CME arrival.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest Electron Flux, as observed at GOES-16

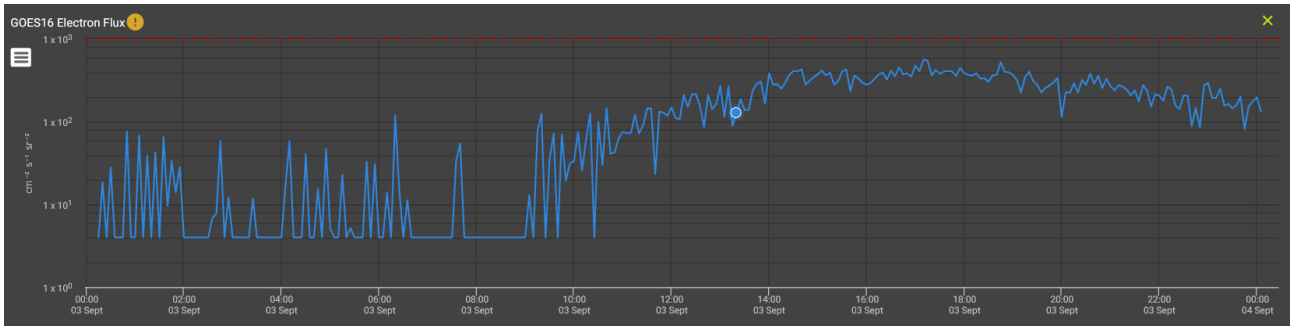


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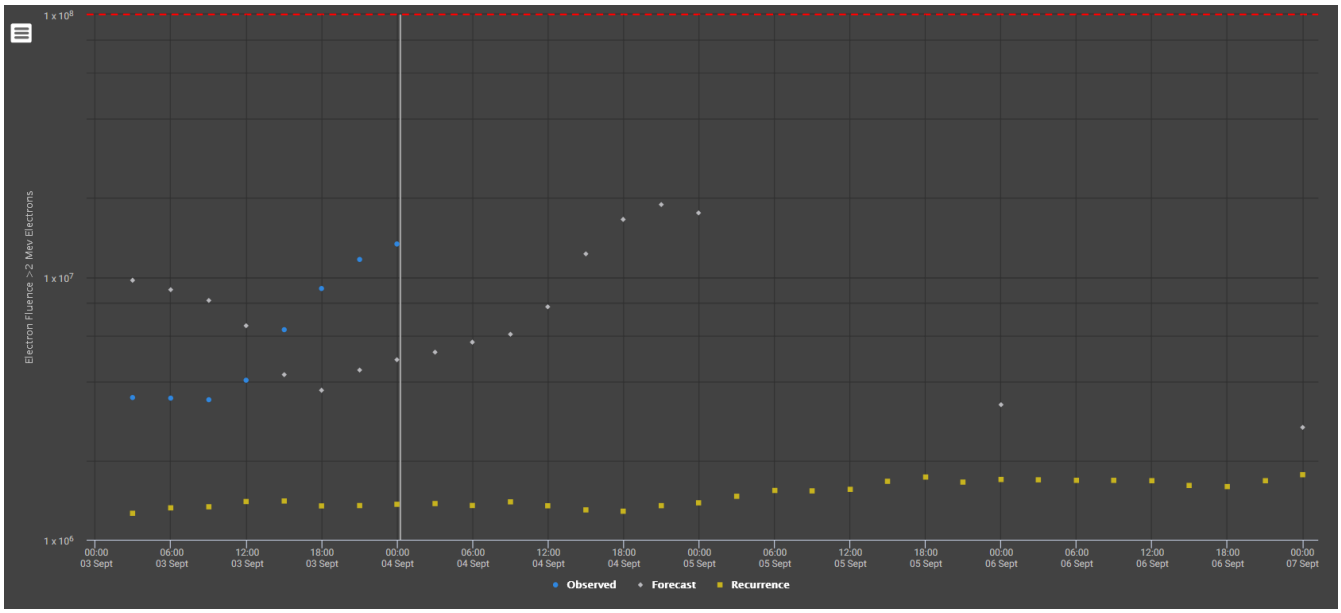
Figure 5: Most recent MOSWOC REFM output



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